# PERSONAL AND HOUSEHOLD ARRANGEMENTS IN RELATION TO HEALTH,

INCLUDING HINTS WITH RESPECT TO THE USE OF GAS, GAS-STOVES, AND OF MODERN WALL-PAPERS.

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MR. CHAIRMAN, LADIES, AND GENTLEMEN,—I am here this evening to deliver a lecture on "Personal and Household Arrangements in Relation to Health, including Hints with Respect to the Use of Gas, Gas-Stoves, and of Modern Wall-papers," which, to render as clear and as practical as possible, it will be my duty to illustrate with the aid of experiments and diagrams.

The lecture is delivered in pursuance of a plan adopted with manifest success some time since by the Sanitary Association of Manchester and Salford, by which it hopes to cause each person who attends a lecture, or who reads it after its publication, to become a partner with it in its attempt to promote the health and well-being of the people of this district.

On looking over the lectures already delivered and published on behalf of the Manchester and Salford Sanitary Association, by Doctors Noble, Ransome, Sinclair, R. Angus Smith, Haddon, Vernon, and Mr. Estcourt, your public analyst, I feel it but right to state that I know of no more able, explicit, and valuable series of lectures on public health than the series to which I am now referring. And I also desire to state that from the necessity of, as it were, "keeping the ball a-rolling"—that is, of continually quickening up the interest and the knowledge of the public, especially of the less informed and less favoured portion of

it—the work done has not only been well done, but it has been amply done. Experience, however, has shown the Association how really difficult it is to sufficently interest the general public in those questions of hygiene and sanitation in which it undoubtedly should have the greatest concern, and on which its real well-being as a community essentially depends.

Lectures have already been delivered to you on "Seeds of Disease," "Foul Air," "Pure Air in Relation to Health," "The Dwelling-house in Relation to Health," and various other subjects of the highest importance in relation to the public health and well-being. My more immediate duty this evening will be not so much to point out to you what particular districts you should live in, what particular houses you should inhabit, what particular forms of drainage the public authorities should adopt in your streets, but, living in the houses and streets in which you do live, and with the conveniences and resources already at your disposal, how you should best regulate your personal and household arrangements and habits, so as to secure to yourselves and your families the highest degree of health and comfort attainable under the circumstances in which you actually find yourselves placed. In pursuance of this object it will be my duty to lay down a series of special rules, the observance of which is absolutely necessary in order to secure to yourselves and your families that inestimable advantage, "sound health." Further, I wish to establish these rules, not as the outcome of the reflection and genius of the philosopher and the man of science, not as a mere set of abstract principles or precepts requiring great learning or ability to comprehend, but as the simple common-sense outcome of some of the most obvious and manifest workings of nature; as the consequences of the most obvious properties of some of the most common and abundant substances in the world—substances with which we are in not only daily but in continuous contact—substances, but for the action of which, not only what we usually call our bodies, but our minds also, would instantly cease to work, and life itself cease to be a possibility. To establish these rules on the basis indicated I shall have to bring before your notice several simple experiments, some of which you have doubtless seen "many a time" before, but, possibly, have never heard them called "experiments."

I have on this plate a small piece of *gun-cotton;* on this second plate a small quantity of *gunpowder;* and here an ordinary composite *candle.* I now apply this lighted match to the gunpowder

which *explodes;* to the gun-cotton, and it explodes ; to the candle, and it takes fire and burns with a flame, which gives out both *heat* and *light.* Why do I call these simple operations—the explosion of the gunpowder and the gun-cotton, and the kindling of the candle—experiments? An experiment is a something done, however simple, for the purpose of getting *knowledge;* or, as we not unfrequently term it, "getting *experience.*" You have frequently before now seen gunpowder and gun-cotton explode, and candles burn, but have you ever asked yourselves why they take fire or explode when the lighted match is applied? These are the questions I now ask you to consider—Why do they fire or explode? What do they do when they fire or explode? There is not one here but knows of the awful, destructive energy of gunpowder when it explodes in large quantities, or even when its explosion is regulated or controlled in the cannon's bore. Every one here knows that flame will both illuminate and burn. All effect is produced by *cause,* by the exercise of *power*—such effects as these only by the exercise of great *power.* But whence the source of this power? Its source is in the gunpowder, the gun-cotton, the candle itself. The gun-cotton, the gunpowder, are made up chiefly of certain so-called *chemical elements,* termed carbon (charcoal), hydrogen, oxygen, and nitrogen. The candle contains carbon, hydrogen, and oxygen only. These chemical elements—the carbon, the hydrogen, the oxygen, and the nitrogen—possess, hidden away in their substance, a vast amount of quiet, *stored-up* energy—of power in a state of perfect *rest;* or, in the technical language of the physicist, a store of **potential energy.** But this store of energy, so quiet and unobservable in the ordinary state of the gunpowder, gun-cotton, coal, or candle, may be suddenly *unloosed*—set free in the *active* form ; or, as it is termed in technical phrase, be changed into the form of **kinetic energy,** possibly destroying all before it. But, for simplicity's sake, let me more especially draw your attention to this candle now before me. Here is the candle, quiet, cold, inactive, consisting almost wholly of carbon and hydrogen, and it would, in its present inactive state, last for ever ; but I now apply a lighted match to it. Note what immediately takes place. The substance of the candle—the carbon and the hydrogen of the tallow and the wick—immediately begins to combine chemically, under the influence of the heat, with *another* chemical element, the *oxygen* of the air surrounding the candle. This element, the *oxygen,* also possesses its store of quiet, resting

energy (its potential energy), and when the oxygen begins to *combine chemically* with the carbon and the hydrogen of the candle, the quiet energy imprisoned in the said three chemical elements is immediately set free in the form of active (kinetic) energy, manifesting itself in the form of the light and the heat of the burning candle. When the candle is unacted upon by the oxygen of the atmosphere it remains inactive and entirely unchanged, and would, in fact, of itself, as I have previously said, last for ever—that is, as long as the world itself shall last. But if acted on by the oxygen of the air it immediately begins to be consumed, and simultaneously to set free its imprisoned latent energy in the form of heat; and the more rapidly its imprisoned energies are unloosed, the more intense are the heat and light it gives out, and the sooner the candle is entirely destroyed.

But I imagine many of my audience are beginning to inquire by this time, What has all this talk about gunpowder, gun-cotton, and burning candle to do with "Personal and Household Arrangements with Regard to Health"? It has everything to do with it. The human body—your body—in its state of health, is the most perfect of all created things in this world. It is a most complex machine (we call it an *organisation*), capable of doing the highest kind of work that has to be done in this universe. It performs the most exquisite physical movements; it thinks; it feels; it loves; and it reasons. When its various parts perform their various functions and duties in harmony with the natural laws which its Creator has established for its government, it is a source of happiness and well-being, not only to itself, but to all around. When it goes wrong (and it never does so but through our own misconduct, voluntary or involuntary), it, on the contrary, causes us to become a source of trouble and misery, not only to ourselves, but, to a greater or less extent, to our friends and relations and the rest of the community. Nay, such misconduct or disobedience of natural law, not only may, but it actually does, cause the human body to become a centre from which extends a widening circle of infection, misery, and death, such as, in fact, it is the especial object of this Association to arrest and destroy.

But, I ask again, whence is derived the power with which the human body does its work—by which the living man moves and thinks? The answer is obvious. The source of this power is the *potential energy*, of which we have previously spoken, here stored up in the chemical elements—the carbon, the hydrogen, and the nitrogen of the blood and tissues of the body, and of the

food out of which these tissues are moulded or built up. How is this energy liberated? Precisely as in the case of the combustion of the candle and the gun-cotton—by the action of oxygen as it enters into chemical combination with these same chemical elements, and unlocks or sets free their imprisoned energies, liberating them in the form of physical, muscular, and mental power—that is, in the doing of that higher form of work, with the object of doing which our Maker created man, whom He has Himself described to be His own masterpiece.

But whence comes the oxygen which unlocks the imprisoned energies of the dead food, thereby enabling it to become a source of living force to the human organism? It is derived exclusively from the surrounding air. A knowledge of the conditions of healthy life thus implies such a knowledge of the nature and properties and composition of air, and of the structure and action of our own bodies—of our lungs more especially—as shall enable us to understand the mode in which its oxygen is carried into the interior of the body, and of its action when arrived there. Without this knowledge there can be no intelligent appreciation of "Rules of Health." My chief aim this evening will therefore be to explain to you as briefly as possible, with the aid of physiological diagrams and of a few simple chemical experiments, the physiology of the lungs—the reason why we breathe, and the action of the *oxygen* of the air on the blood and on the tissues of the body; and having done this, to lay down certain practical rules indispensable to the preservation of "Health in the Household."

Allow me first to invite your attention to a very simple experiment—nay, further, allow me to ask you to perform this experiment yourselves, each individually for himself. It is, indeed, a very simple experiment, but one fraught with instruction of the most important character with regard to the health of all the dwellers in the houses of large towns and cities in which gas is habitually consumed as a source of household illumination.

Take a perfectly *clean*, *cold*, *dry* tumbler, and hold it, for a moment only, over a lighted candle or a gas flame. Its interior immediately becomes dimmed over with a coating of *dew*, with a layer consisting of an infinite number of microscopical drops of water.

Whence does that water come? It was not in the substance of the candle, nor in the substance of the gas. It formed no part of either. Whence, I ask, then does it come?

This water, which did not previously exist, has been formed or generated at the expense of that constitutent of the atmosphere

whose action on your bodies—that is your blood and your tissues—is the source of *all* your *energy;* the source of all the mental and muscular power you possess; of all the health and pleasure you enjoy. Its active presence is the very condition of life itself. Without its magic and vivifying influence, in all around there would be the blankness of death. Verily, from this experiment we can therefore learn much—much that it is most important that the mothers, especially of our poorer and less fortunate fellow-creatures, should know.

Let me invite your attention to the explanation of this strange *phenomenon*—this production of *water* by the action of *fire*—that is, of gas or candle flame. The whole of this terrestrial globe is surrounded by a thick layer or ocean of mixed gases, termed the *air*, or the *atmosphere.* It is popularly said to reach to a height of about 45 miles above the level of the sea, and to weigh about 15 pounds to the square inch, so that every man, woman, and child, as he or she moves about, has to support a weight varying according to size, up to eight or nine tons.

The total weight of the atmosphere has been estimated at 4,850,000,000,000,000 of tons. This atmosphere is as essential to the life of man and of the higher animals, and even more so, than is water to the life of fishes. This atmosphere, or world-enveloping layer of mixed gases (frequently, to distinguish it from other mixtures of gas, it is termed **common air**—at once the cheapest and the most important material in this world) consists essentially of two gases. The one named by chemists *nitrogen* is apparently one of the most inert, inactive, and *powerless* of the whole of the known gases, and is therefore usually described as being distinguished by its *negative* properties. It has neither colour, taste, nor smell; is quite invisible; and will neither support life nor combustion. Its sole use in the atmosphere is, apparently, to dilute, weaken, or lessen the energy of the second and by far most important constituent of the atmosphere—the *oxygen.*

If there be in this world any body, thing, or substance which is entitled to the epithet of *magic,* it is this said oxygen, this second constituent of the atmosphere. Without the play of its tiny molecules in the hidden recesses of the brain there would be no fancy, no reasoning, no thought: nay, even consciousness itself would cease. No movement of the body, or of any part of it, however minute—that is, of movement emanating from the body itself, though it be only the sportive winking of an eyelid—but is due to the magic power of this wonderful oxygen.

In the diluted form in which nature most loves to present this beneficent oxygen to the children of this earth, it is purest on the mountain side, on the moorland plain, and on the wide and trackless ocean; and is found most polluted and least endowed with its wonderful energy in the crowded rooms, fetid cellars, and noisome back courts of those portions of our villages, towns, and cities in which human ignorance, poverty, filth, and degradation do most abound.

But there are also certain places and conditions in nature under which this same magic oxygen acquires still more wonderful life-giving, health-promoting, disease-healing powers. By the side of the waterfall, on the vast moorland plain, by the laving of the sea-wave, and in the track of the lightning flash, its health-establishing powers are greatly intensified, and we then know it under the term **ozone,** a substance distinguished by its *absence* in the track of plague and pestilence, and by its *presence* in the regions where human health and physical gladness and buoyancy are, as it were, most indigenous.

Whether this *ozone* owes its health-promoting properties to its *direct* action on the animal system, or to its power of destroying *contagion* and other agencies and influences adverse and injurious to health, is still a subject of discussion among scientific men. Of this, however, there can be no doubt, that where ozone most abounds, there, in general, is the region of physical health; and where it is *most seldom* found, there, in general, is found most of human sickness and physical debility.

Allow me, now, to introduce to your notice another experiment. I take this small piece of phosphorus—as you know, a very inflammable substance. I ignite it, and place it in this inverted gas jar, carefully placing the mouth of the jar under water. Observe what takes place. The phosphorus almost immediately begins to burn with lessened energy. It is now extinguished, and the water slowly rises until, as you see, it fills about one-fifth of the interior of the gas bottle, when it ceases to rise any higher.

Why did not the *whole* of the phosphorus burn away, and why did the water not continue rising till it reached the *top* of the bottle? Why did not the *whole* of the *air*, and not about *one-fifth* only, disappear from the interior of the bottle? The answers to these questions are obvious. The colourless *invisible gas,* to which I am now directing your attention, which fills about four-fifths of this bottle, is **nitrogen** gas—a non-supporter, not only of combustion, but of *life* also; and the gas which has disappeared from the

remaining one-fifth of the bottle is the magic oxygen of the air, that element on whose presence the life and health giving powers of the air chiefly depend. It has disappeared in its gaseous form by entering into combination with the phosphorus, and producing with it a solid body, termed by the chemist, phosphoric anhydride, of which I need say nothing further.

We have thus seen by rough experiment that atmospheric air consists in round numbers of a mixture of one volume or measure of oxygen gas with four equal volumes or measures of nitrogen gas.

More accurately, adopting the data of Dr. R. Angus Smith, we may regard the pure air of the mountain, or of the country plains, as consisting, when dried, of—

| | Per Cent. |
|---|---|
| Nitrogen Gas | 78·98 |
| Oxygen | 20·99 |
| Carbonic Acid | 0·03 |
| | 100·00 |

But, in addition to these substances, ordinary air invariably contains a certain admixture of aqueous vapour and of *minute solid particles* floating in it, to which I shall have occasion presently to refer more minutely.

Inasmuch as our attention during this lecture will be almost continuously drawn to the properties and the action of the two substances—the **oxygen** and the **carbonic acid** of the diagram before you—I have had them written out on the blackboard in specially large characters. The former, the oxygen, I have elsewhere had occasion to refer to as the "good genius," the good "fairy spirit" of the atmosphere, and the latter, the carbonic acid, as its bad spirit, its "demon sprite."

But I wish to demonstrate experimentally the properties of the gases of which I am now speaking to you, so that you shall see with your own eyes and judge with your own senses the truth of the statements I am putting before you. I have here a jar of **nitrogen** gas, prepared before the beginning of the lecture. You see it is, as I have previously described it, a colourless, invisible gas. I introduce into it this lighted candle, which is immediately extinguished; and were I to place a mouse, or any other similar small animal in it, it would quickly expire. Nitrogen gas, therefore, is neither a supporter of life nor combustion—it acts simply as a *diluent* of the oxygen by its *negative* properties, lessening the

otherwise too energetic action of the latter gas, just as water dilutes alcoholic spirits.

Let us now turn our attention to the second, the overwhelmingly important element of the atmosphere—the **oxygen.**

**Oxygen,** a jar of which I now hold in my hand, is, in its free state, as you will observe, a colourless, invisible, inodorous, and tasteless gas. It is *un*inflammable itself, but is a most powerful supporter of the *combustion* of all common inflammable substances, carbon, phosphorus, and iron burning in it with resplendent brilliancy, and the red-hot wick of a candle immediately bursting into flame on being introduced into it.

I take this taper, the flame of which I have just extinguished, but whose wick still glows at a red heat, and plunge it into a jar of oxygen, and it immediately bursts into a brilliant flame.

I repeat the experiment with a red-hot match, or wooden splinter, and it does the same.

I plunge this piece of steel watch spring, tipped with burning sulphur, into oxygen, and it immediately begins to burn with the most vivid scintillations, the heat developed by its combustion becoming so intense that the burning drops, falling through the layer of water which, more or less, protects the plate, fuse their way into the very substance of the plate itself. The product of the combustion in this case is an oxide of iron, a substance having the same chemical composition as the best Swedish iron ore—as loadstone, or natural magnet, and as the black scales which cover the forge and floor of a blacksmith's shop.

I now introduce into this jar of oxygen a piece of burning phosphorus. The phosphorus, as you see, immediately bursts into a state of splendid combustion, the intense brilliancy of the combustion when performed in the dark being such that the eye can scarcely endure it. The product of this last combustion is termed phosphoric anhydride. This substance, in union with lime, forms the most important earthy constituent of bone—in fact, that substance from which phosphorus itself is extracted by the practical chemist, who, as most of you know, obtains his phosphorus for the manufacture of lucifer matches, and for other purposes, from burnt bones.

Now let me draw your attention, in the same way—that is, experimentally—to the properties of **Carbon dioxide**, or, as it is more popularly termed, **Carbonic Acid Gas**, the chief *poisonous* product of all ordinary combustion and of animal respiration—the "demon sprite" of the atmosphere of our dwellings, whose noxious

influences it is one of the chief objects of the sanitarian to remove or to neutralise.

Carbonic acid is most easily prepared in large quantities by dissolving marble in diluted muriatic or hydrochloric acid. Into this glass vessel, termed a Woulffe's bottle, containing some common marble (carbonate of lime), previously broken into small pieces, I pour a mixture of hydrochloric acid and water. As you will observe, effervescence immediately commences, and a colourless invisible gas immediately begins to pass out of the bent tube attached to the bottle. This *carbonic acid gas*, which is now flowing from the bent tube into the bottom of the tumbler, is, as you will perceive, a very *heavy* gas. Into this glass tumbler which you have just seen me fill with gas I introduce a lighted candle. It is immediately extinguished.

I now fill another glass tumbler, in a similar manner, with carbonic acid gas, which I pour from it into a third tumbler containing common air only. Into this last tumbler I introduce a lighted candle. The flame is immediately extinguished, thus proving that not only is carbonic acid gas a non-supporter of combustion, but that it is also a very heavy gas, and may be poured from one vessel to another, like water. In the same way, by introducing a small animal into the bottom of a jar of this gas we can show that it is a non-supporter of life.

But I have one or two other experiments with carbonic acid gas to which I wish to draw your special attention. I have here a bottle containing *lime-water*—that is, a bright, transparent, colourless solution of common lime—and I have here another jar of carbonic acid gas. I pour the colourless lime-water into the carbonic acid. The lime-water immediately becomes *white* like milk, and the soluble lime is immediately changed into insoluble chalk or carbonate of lime. No other gas will produce this effect. Lime-water is therefore said to be a chemical *test* for carbonic acid gas.

The next two experiments to which I have to ask you to direct your attention are of the greatest importance in the science of health. I hold this inverted glass tumbler over this burning candle for a moment or two only, but with a different object to that for which I performed the experiment earlier on in my lecture. I now remove the tumbler from over the flame, cover the mouth quickly with the palm of my hand, quickly pour a little lime-water into the tumbler, and agitate briskly, still keeping the mouth of the tumbler closed with my hand. You will observe the colourless transparent

lime-water has again become quite white and *milky-looking*, thus proving that carbonic acid gas is produced by the *burning of the candle.*

I have here a glass containing nothing but the clear, colourless lime-water, and a narrow glass tube about twelve inches long. I breathe through the tube, which passes down to the bottom of the lime-water. As you must already have observed, it has changed to the milky-white appearance with which we have become familiar. This last experiment clearly proves that when we breathe, we breathe out this poisonous carbonic acid gas, and that this carbonic acid gas is the same gas which is produced when we burn a candle or dissolve common marble.

I have but one experiment more on the carbonic acid gas part of my subject with which I desire to occupy your attention. The chemist says that carbonic acid gas consists of carbon and oxygen in a state of chemical union in the proportion of *one* atom of carbon to *two* atoms of oxygen, and he represents a molecule of carbonic acid, or carbon dioxide, by the symbol $CO_2$.

Let me now prove to your satisfaction that this carbonic acid gas, which we have described as one of the "demon sprites" of the sanitarian, *is* made up of carbon and oxygen exclusively.

I have here a bottle containing oxygen gas only, which produces no change in the appearance of lime-water, and I have here a small piece of charcoal, which for our purpose we may regard practically as consisting of pure carbon. I ignite or kindle the charcoal, and plunge it into the jar of oxygen. It burns with resplendent beauty, even in the common gaslight of this room. I now pour into the gas jar this same colourless, transparent, lime-water, this test for carbonic acid gas, and you immediately observe it becomes milky-white. As we have assumed no other substances to have been present in the jar during this experiment than the oxygen and the carbon it evidently follows that carbonic acid consists exclusively of the chemical elements *carbon* and *oxygen.* And we may at once, therefore, in order to save time, accept as proved, the inevitable conclusion that the carbonic acid gas evolved from the body in the process of breathing is produced by the chemical combination of the oxygen of the air, taken into the body during the act of breathing, with the *carbon* of the food, or of the tissues of the body itself; and that the heat and energy developed in the body are also in greater part due to such chemical union of carbon and oxygen.

Hence it will be obvious to all that wherever, in any dwelling-

room, or elsewhere, where the air is doubly vitiated by the burning of gas, or the breathing of men and women, a duplex process is going on by which the air is being *robbed* of its vivifying, health-giving oxygen on the one hand, while it is being *poisoned* by the addition of noxious carbonic acid gas on the other. Can it be wondered then, especially in the cases of the very young, of the feeble in health, and of the poor and under-fed, that human health is destroyed, and that disease and fever become rampant?

Hence also follow equally obviously, and with equal force, the two fundamental principles of health in the dwelling-house, viz.—

1. Keep the air perfectly pure.

2. Change the impure for pure air as often and completely as possible, which may be paraphrased into—**ventilate** thoroughly.

There can be no healthy dwelling-house in the absence of good ventilation, never mind how admirable the situation, or how healthy the surroundings of the district.

But this can be illustrated in no way more impressively than by a simple experiment, which I not only now wish to perform before you, but which I especially request you to be good enough to perform at home before your own household.

My experiment on ventilation, a very simple but most impressive one, is the following: Take a cylindrical glass gas chimney, of about 10 inches or 12 inches in length—the longer the better. Then take a short piece of candle, cut flat at the bottom, about half an inch long. Light the candle, and place it down on the flat table, and place the glass chimney perpendicularly over it, its lower end resting on the table and its upper end open to the air. As you see—the flame almost immediately begins to grow dimmer, and now it is quite extinguished. Nothing can more clearly illustrate the necessity of ventilation than this experiment.

I now, as you see, repeat the experiment, but with this important variation—that, just as the flame is about to be extinguished, I introduce vertically *into* the open end at the top of the glass chimney, so as to divide it into two halves, a piece of card, about one inch or two inches long, and immediately, as you perceive, the dying flame revives, bursts into renewed vigour, and the candle burns as brightly as at first. A system of ventilation has been established.

But in what way did the introduction of a plain piece of card produce this apparently miraculous result on the flame? Simply

by dividing the upper part of the chimney into two halves, *down* one of which a current of cool fresh air descended to support the combustion of the candle, and *up* the other of which ascended a current of hot air, conveying away with it the products of combustion, which, unless quickly removed, would suffocate the flame. May I ask all here, who now see me perform this simple experiment, to repeat it at home, and ponder over the important truths it conveys?

But in addition to the gaseous constituents of the air, to which I have already drawn your attention, there are always, under ordinary circumstances, present in it, floating through its mass, a number of mechanical impurities, of **solid particles** too minute to be visible in ordinary daylight.

If I were to ask the various members of this audience individually whether they had ever seen *light*, or in other words, if light was visible, the answer, in at least nine cases out of ten, would be—yes. This, however, would be wholly an error—light, though a cause of the visibility of surrounding objects, is itself perfectly *in*visible. Light cannot itself be seen.

I now want to ask you to perform an experiment, or rather to make an observation, which the circumstances of this lecture-room will not permit my bringing more directly before you.

I want you, some bright sunny morning, when the sun is shining directly on your windows, and before the shutters are opened, to go into a darkened-room, and placing yourselves on one side of the room, so as to look at right angles across the direction of the beams of light, which break their way through every crack or chink in the shutters, and carefully to observe what is there to be seen. You will imagine you see long straight lines of sunlight of various breadths and thicknesses stretching across the room, but you see no such thing. The light itself is *invisible*, but what you do see is the powdered dust—the minute particles of **solid matter** diffused everywhere through the atmosphere of the room, and rendered visible by the sunlight which accidentally falls upon them.

Of what then do these solid particles, these mechanical impurities, chiefly consist? They consist partly of mineral matter, but chiefly of the dust of broken-up animal and vegetable matter, which, because of its greater lightness or buoyancy, continues to float longest in the atmosphere. Speaking more definitely of the impurities present in the atmosphere of our towns and cities we may describe them as consisting of—

1. The products of animal respiration.
2. The products of putrefaction.
3. The products of combustion.
4. The products of various manufacturing operations.
5. The products of the wear and tear of life, the friction and the turmoil of the streets flinging into the air vast quantities of minutely-powdered animal and vegetable, or offal matter.
6. **Disease germs.**

I now ask you to perform one more experiment only. Into your darkened room take a red-hot poker, and hold the heated part in the middle of one of these beams of light—around the heated end of the poker immediately all becomes comparatively dark. The floating dust consists chiefly of **organic matter**, and is at once *burnt up*, and nothing is therefore left to reflect the light—hence the darkness around the poker.

If this darkened room, in which you are supposed to perform your experiment, were so thoroughly well-built as to be free from all vibration, and were closed thoroughly from the external atmosphere, this dust which you have seen diffused in the path of each ray of sunlight would be ultimately deposited on the walls and on the floor, and then you would no longer be able to see the path of the sunlight across the room. The air of the room thus becomes optically pure and transparent by the mere mechanical deposition of its floating particles. But it also undergoes another and much more surprising and important change—a change of the utmost importance in its bearings on the hygiene of practical life. Professor Tyndall, to whom we are indebted for this knowledge, also found, by actual experiment, that though flesh meat, meat juice, broken eggs, and other similar animal substances, kept in *un*purified air—air in which the dust particles were still floating—would begin in warm weather to putrefy in a few days, they might be kept weeks, and even months, in air purified by the mechanical deposition of the floating dust particles it ordinarily contains.

Hence it follows that the putrefaction of animal and vegetable substances in hot weather is chiefly due to the action of minute solid bodies, *germs*, deposited in their substance by the atmosphere.

While on the subject of the impurities of the atmosphere, it is but right to state here, and speaking to a Manchester audience, that it is, in the present state of our knowledge, quite impossible to treat this subject fully, much less exhaustively, without frequent reference to that most able, elaborate, and encyclopædic work of our well-known citizen, Dr. Robert Angus Smith, which he has so appropriately entitled "Air and Rain." To Dr. R. A. Smith

belongs not only the merit of priority but also of greater extent and thoroughness of investigation on this important subject than probably belongs to any other scientific man in England, not even excluding Professor Tyndall, to whose original and valuable investigations I have so recently referred.

Before dismissing this part of my subject, a word about the origin of contagious and infectious diseases—a word about **disease germs.**

In the present state of our knowledge it can scarcely be doubted that smallpox, measles, and scarlet, typhus, and typhoid fever, originate in and are propagated by means of exceedingly minute organised bodies—too minute even to be recognised at present by means of our best microscopes—termed **disease germs.**

There is almost equally little doubt that each form of fever, as scarlet fever, typhoid fever, &c., is propagated by its own **specific form** of **fever germ**; there is equally little doubt that each specific form of fever germ requires for its growth and propagation a specific kind of *pabulum*, or nourishing material, on which it may feed and thrive, and in the absence of which it starves and dies out; and there is perhaps equally little doubt that the pabulum necessary for each kind of fever germ is to be found in specific parts of the body only, and not generally or elsewhere in that same body. To such *resting-place*, where such *disease germ* shall find its necessary *pabulum*, or food material, the term **nidus** is applied. A **disease germ**, therefore, cannot develope and produce its specific form of disease, even though it enter the body and *pass into* and *circulate* with the *blood*, unless it reach its proper **nidus.** Nay, it will not even germinate there, so as to propagate disease, unless at its **nidus** it find its own **specific pabulum.** These germs are so small that they cannot exceed the fifty-thousandth of an inch in diameter. The proper nidus of the **smallpox germ** is most probably the **deeper layer of the skin**, the nidus of the **scarlet fever germ** is the **outer layer of the skin**, the nidus of the **measles germ** is the **skin** and the **mucous membrane of the throat**, and the nidus of the **typhoid fever germ** is probably the **glands of the intestines.**

I regret that my very limited time will not permit of my adducing, in support of this, the "germ theory of disease," even a portion only of the data on which this most important of modern scientific theories is based. Its bearings on the subject of our

inquiries this evening is, however, most obvious. To those who may desire to pursue it further I would say, read Dr. Maclagan's most able and lucid treatise on this subject.

One word more on the **propagation of typhoid fever** before I leave this topic. It is now generally admitted by scientific pathologists that **typhoid fever** can only be propagated by means of the **excreta** passed out of the intestines of a patient suffering under an attack of that disease. It is also generally admitted that **typhoid fever** is almost invariably propagated by the **water we drink.** What a reflection is here on the purity of our personal habits, and on the efficiency of our sanitary arrangements! Let me just note, incidentally in passing, that **typhoid fever** is a disease that can be most easily **stamped out** by means entirely within our command, and that every nurse or other responsible person who permits the stools of a typhoid fever patient to be received into a vessel not already containing a small quantity of **carbolic acid,** or some other equally efficient **disinfectant,** is guilty of gross and criminal negligence, unless, indeed, for a special purpose, prohibited from doing so by the medical attendant.

Our next question, which we answer very briefly, is, How does this *oxygen*, so necessary to unloose the energy so quietly stored up in the carbon, the hydrogen, and the nitrogen of our food, our blood, and our tissues, *enter* and become *distributed* through the human system?

The air, including the much-wanted oxygen, and the not-wanted disease germs and other impurities, enters the body by the mouth and nose, and passes by the air-tubes into the lungs. From the lungs it passes into the blood, and from the blood it passes through the walls of the ultimate blood-vessels to the tissues, which it burns, thus unlocking their stored-up energies for the purposes of the living body.

The **lungs**, as you see by the diagrams before you, are the two large, light, spongy organs which fill nearly the whole of the chest, or upper part of the trunk. They contain an immense number of funnel-shaped **air-sacs**, the sides of which are indented, with the object of greatly increasing their surface, with deep concavities or depressions termed **air-cells.** So thin are the walls of these air-cells that they may be regarded as very little thicker than those of common soap bubbles. On the outside of the walls of these air-cells are placed myriads of minute thin-walled blood-vessels, termed **capillaries.** These capillaries, which are much smaller

than the hairs of the head, form systems of network which completely envelope the air-cells and air-sacs. The *air* in the air-cells and the *blood* in the capillaries, which surround them, are thus brought so exceedingly near as only to be separated from each other by moistened membranes of almost *inconceivable thinness*. The needful **oxygen** soaks through the thin walls of air-cell and blood-vessel into the blood, and the **carbonic acid**, which has made the blood brought to the capillaries impure and practically useless, soaks away from the blood in the opposite direction, and the blood thus becomes repurified, and again fitted to circulate through the body, and awaken fresh life energies along its triumphant course.

The **lungs** thus consist essentially of an arrangement by which an exceedingly large *surface of air* is continually being presented to an exceedingly large *surface of blood*.

But why does fresh air continually *enter*, and used-up air continually *leave* the lungs? or, in other words, what is the mechanism of breathing? The lungs are contained within the walls of the chest—the walls of the chest are movable to a certain extent, in their action resembling those of a pair of common bellows. When the walls of the chest are raised, or moved outward by the action of their muscles, the cavity of the chest is enlarged, and fresh air forces its way into the lungs, and we are then said to *inspire* air. When, on the contrary, the walls of the chest fall, or are pulled inward, they tend to compress the lungs and expel the used-up air, and we are then said to *expire* air.

Before, however, we can be said properly to understand this process of respiration, or breathing, we must know something of the composition of the blood, and the part played by each of its chief components.

The blood consists of (1) a clear, nearly colourless, liquid—the **liquor sanguinis**, which nourishes the body and floats the *red* and *white corpuscles*. (2) The **red corpuscles**, which are minute microscopic circular discs, of a faint straw colour, and about the three-thousandth of an inch only in diameter. These corpuscles *absorb* oxygen gas in the lungs, and *give it out*, during their passage through the capillaries, to the neighbouring tissues. They have, therefore, been termed **oxygen carriers.** It has been calculated that 10,000,000 red corpuscles would lie on the surface of one square inch. (3) **White corpuscles,** into whose uses we need not now inquire.

When the blood *enters* the lungs it is very impure, and of a

**dark-purple** colour. It then gives out carbonic acid, and absorbs oxygen, and *leaves* the lungs purified, and of a **bright-scarlet** colour, to enter the general circulation.

Oliver Wendell Holmes, the celebrated American poet, at once both physiologist and poet, expresses in the following beautiful language the changes I have described :—

"The smooth, soft air, with pulse-like waves,
Flows murmuring through its hidden caves,
Whose streams of brightening purple rush,
Fired with a new and livelier blush;
While all their burden of decay
The ebbing current steals away,
And, red from Nature's flame, they start
From the warm fountains of the heart.

"No rest that throbbing slave may ask,
For ever quivering o'er his task,
While far and wide a crimson jet
Leaps forth to fill the woven net
Which in unnumber'd crossing tides
The flood of burning life divides,
Then, kindling each decaying part,
Creeps back to find the throbbing heart."

Having thus at length cleared our way to an intelligent appreciation and understanding of the general subject of my lecture, I proceed, without further delay, to conclude my address to you this evening by laying down briefly, but emphatically, a series of most important rules bearing on "Personal and Household Arrangements" as they affect the health of the community.

**Be sure you never collect water for drinking, or for the purposes of cooking, without first drawing off sufficient water from the tap to empty the leaden pipe of the water previously standing in it.**

In this way you will lessen the probability of your being poisoned by compounds of lead or other metal.

**If you have no proper cistern, and are obliged to collect your drinking water a long time before you use it, be sure you store it up in glazed stone mugs, covered by glazed stone covers.**

**Be sure you boil your water, in all such cases, before drinking it.**

In this way you avoid or kill disease germs, expel the products of putrefaction, and also arrest the putrefaction of any organic matter the water may still contain.

**Use filtered water only for drinking.**

You may easily construct a filter for a few pence only. Get a ommon flower-pot. Cover the hole at the bottom with a piece of erfectly clean *well-washed* flannel. Change this occasionally. ver it place about three inches of *well-washed* fine gravel, then layer of *well-washed* fine sand. Over this place a layer of *vell-washed* (with boiling water) finely-pounded animal charcoal, bout three or four inches deep. Place the bottom of the flower- ot over a glass vessel, pour water through until it comes out erfectly clear, and it is then fit for use.

**Be sure, especially in newly-drained districts, that your bed-rooms are not on the ground-floor.**

Recollect what we have said about the cooled products of ombustion and of breathing—the carbonic acid and the condensed queous vapour—the gaseous and powdered products of putrefac- ion, and of the wear and tear of animal and vegetable substances lways present in the air of towns—the emanations from the soil—ay, think of the *disease germs* themselves. These all tend to fall own upon or collect near the surface of the ground. Manifestly, nore need not be said in support of this rule.

**Do not sleep in a room with a closed chimney, still less in a room without a chimney.**

The close, sickly smell, which is experienced by a person entering directly from the fresh air into an ordinary closed bed-room the first thing in the morning, is direct evidence of the want of effective ventilation. The odour arises chiefly from the organic exhalations of the lungs and skin.

The chimney opening, when free, alone tends to promote at least some ventilation. Before the present "Lodging-house Act" came into force, it was not unusual in some of the lowest lodging-houses to find from 15 to 20 people sleeping in one small room, some lying on bedsteads, some on the floor. Those sleeping on the floor, too poor to pay for the use of bedsteads, would escape fever, while the less indigent, sleeping on bedsteads, would be stricken down with it. The explanation of this apparent anomaly was—those on the floor slept below the line of the opening of the chimney, and therefore in a ventilated part of the room, while those raised up on bedsteads slept in the unventilated region above the chimney opening.

To keep the air of the bedroom quite fresh and wholesome during the whole night, a current, for each person sleeping in it, of at least 3,000 cubic feet per hour of pure unbreathed air must pass through the room.

**Be sure you do not take a house in which the upper window-frames cannot be pulled down.**

In many houses, including even not a few middle-class houses, the upper parts of the windows of the upper rooms of the house are, to save expense, originally constructed so as to be immovable—that is, are so made as to be incapable of being pulled down or opened from the top. Speak with the builders and proprietors of such houses, and they will tell you flippantly that upper rooms and attics are only meant for servants and children to sleep in.

In many houses, however, the upper windows, though from construction movable, become absolutely immovable when painted. I have met with such windows in houses which having been built several years have evidently, from this cause, never been opened subsequently to the house's being let, and which had become so firmly fixed as to scarcely admit of being opened without damage being done to the window-frames themselves. In any case, of course the physiological effect of sleeping in such rooms is the same, whatever physical obstacle may prevent the windows being opened.

There is one point in relation to this subject of *the opening of windows* on which I feel I cannot speak too strongly. I mean the culpable stupidity — the exceeding fatuousness — of vast numbers of parents, who, during summer, take their children and families down to the sea-side for the benefit of their health. Such parents, altogether regardless of the first principles of health, stuff any number of children into low-ceilinged rooms, which either have no chimney or which have the chimneys closed up with bags of shavings, old rags, or other similar articles, and the window-tops quite immovable. The children so packed away in these summer *health trips* breathe an atmosphere utterly unfit for human beings to breathe, and in most cases many times worse than that breathed at home. Is it to be wondered at, then, that these children, sun-browned as are their little faces on their return home, should speedily show signs of illness, or, as is so frequently the case, be laid down with measles, scarlet fever, or other contagious ailment?

**Be sure you do not so encumber your bedroom windows with curtains, or with mirrors, toilet tables, or other heavy furniture, as to prevent their being easily opened at any hour of the day.**

Practically a window that is not opened because of the vanity or love of finery and display of the occupant is equally as bad as the window of a house which cannot be opened because of the greed or parsimony of the builder.

**Be sure you turn your gas down, or, what is still better, entirely extinguish it, when you are not using it.**

The chief cause of the senseless and prodigal use, or rather abuse, of gas is its comparative cheapness, combined with the facility with which it can be used. Were oil, or candles, burnt to the same extent as well-purified coal gas is now burnt their use would probably be found to be even more pernicious than that of the coal gas.

**Be sure you do not light your gas to warm your bedrooms.**

The reasons for this rule have already been amply demonstrated.

The following facts, extracted from Dr. R. Angus Smith's important work on "Air and Rain," may, however, not be out of place here. Dr. Smith states that :—

"According to Müller, *carbonic acid gas* in the air of a room acts as a *narcotic poison* —that a little more than ¼ per cent of this gas present in the air of a room will make gas or candle flame sensibly *less luminous*—that the breathing of air vitiated with carbonic acid gas causes the number of *respirations* per minute rapidly to *rise*, while the number of *pulsations* per minute rapidly *falls*—that if the heart's beats fall only *one* per minute, the circulation of the blood is diminished by *many gallons* per day."

The bearing of these facts on the health of those living in gas-lit rooms cannot be misunderstood.

**Be sure, as you value your own life and health, and that of your own families, your clerks, and your assistants, that you never use any gas-stoves, without a chimney, to warm any room, either with or without a chimney, in which they spend any considerable portion of their time.**

**Gas-Stoves.**—There are at present only two systems of heating by which our rooms can be healthily and efficiently warmed: (1) That by which each room is supplied with a sufficient quantity of warm pure air from an external source; (2) That

by which heat alone is *radiated* into the room—that is, by which the *heat* is supplied independently of the air to be warmed.

The first of these systems of heating, which we may term that of **convection,** may, for our purpose, be immediately dismissed from attention, inasmuch as it can only be adopted in connection with a complete, complex, and somewhat expensive system of ventilation, and at present at least can only be carried out economically in connection with large buildings.

The second system mentioned, viz., that of heating by **radiation,** is, in the present state of practical science, not only the one most generally adopted, but also the one attended with the most satisfactory results.

Heating by radiation may be carried out on *three* methods, viz.: (1) By close stoves, which are very rarely healthy, and are always attended by a more or less disagreeable odour. Further, this system is not suitable for small rooms. (2) By **radiation** from pipes heated by hot water **circulating** from a central boiler. But this system, whatever its merits in other respects, involves too great an original outlay to permit of its being introduced into cottage or small middle-class houses. (3) By the **open grate.** On this system our rooms are heated by **radiation** from **red-hot coal** burnt in an open grate, the products of combustion escaping up the chimney. This system, so far as consumption of coal is concerned, is perhaps the least economical that could be adopted, and will no doubt be ultimately superseded; but it at least has this additional advantage, that, besides warming the room, it necessarily secures a more or less efficient system of **ventilation.**

All ordinary **gas-stoves** vitiate and poison the air in the direct ratio in which they heat it. They lessen the vital power of the occupant of the room or chamber in proportion as they insidiously promote his apparent comfort; and I have no doubt that many a young clerk, engaged, as is too frequently the case, in a small cold chimneyless room, has prepared his exit from this world before the commencement of the following spring, by his having in early winter endeavoured to assuage the discomfort of the winter's cold by means of that most insidious and merciless of destroyers, the common gas-stove. Such stoves, especially those, say, of the beehive class, not only rob the closed chimneyless chamber of its health and energy giving, though cold, oxygen, but they pour back into its place its equivalent of hot poison, totally unfit to be breathed by human being.

All ordinary gas-stoves either have no pipe or chimney to convey away the burnt gas—the mixture of hot carbonic and watery vapour, or the pipe or chimney is too small to carry away the said products of combustion with sufficient rapidity. Disease and death, especially to the consumptive, lurk in the use of these stoves.

If, on the contrary, they are supplied with pipes, or chimneys, of sufficient width to convey away the poisonous products of combustion—the said pipes convey away so much of the heat as to render such stoves in most cases practically valueless for heating a room. Do not therefore, I say, use any ordinary form of gas-stove in a small close room.

There is a form of gas-stove in common use in which a bright, corrugated, curved copper reflector is made to *appear* to *reflect* the heat. I say made *to appear* to *reflect* the heat, since practically there is no reflection of heat at all—that is, the amount of heat reflected is so small as practically to be of little or no service in heating the room. The man whose interest it is to sell the stove will tell you this stove produces no smell, does not smoke, heats the room by reflection of heat, and is perfectly healthy; and I have known cases in which medical men have selected this form of gas-stove for the use of patients suffering under severe asthma and bronchitis, under the impression that they heated by reflection only, and were therefore perfectly healthy. They were used for heating the bedroom during the long cold hours of the winter nights.

But this is a mistake—these stoves are *shams*. They are not healthy, but on the contrary they are poisoners and pollutors of the atmosphere of the rooms in which they are used. They do not heat the rooms by radiation and reflection. The bright cheerful-looking copper back of the stove only helps to deceive the purchaser and user of the stove, but not to reflect heat into the room.

If these bright copper-backed gas-stoves be examined carefully, they will be found to contain, concealed at the top, above the opening of the stove, a gas-pipe, running from side to side, with a series of gas-jets. Some of these stoves contain an opening at the back for a small chimney, which is, however, generally stopped up, while many contain no such opening. Further, if such opening be not closed, the stove loses nearly all its apparently marked heating power, and fails to efficiently warm or dry damp feet or clothing placed in front of it.

The action of these stoves is as follows. The gas issuing from the jets concealed under the top of the stove is burnt at the expense of the oxygen of the air in the room, which, in the case of the invalid, it is of such importance to keep pure. The *hot* products of combustion, the noxious, though heated and invisible, carbonic acid, and the heated aqueous vapour, unable to make their escape through the top of the stove, flow rapidly out of the open front of the stove, passing over the bright copper at the back, so as to cause the issuing heat to be apparently reflected by it.

The warmth emitted from these stoves is almost entirely due to the hot, poisonous, carbonic acid and the heated aqueous vapour they produce and pour into the room; and, speaking generally, they may be said to *warm* the air of the room just in the proportion in which they *poison* it.

Possibly among the whole of our citizens none are more ignorant of the nature of coal-gas, carbonic acid, and common air than are the makers and sellers of these stoves. Of course I do not mean to say there are no exceptions to this statement. The following incident, in my own experience, will, however, show how gross such ignorance can be. For obvious reasons I do not want to be too definite in my statement. It will be quite sufficient for my purpose to state that on one of the occasions, not many centuries since, when I had to visit an exhibition of various forms of "Fuel Apparatus," held in this district, I paid great attention to the various forms of gas and smokeless stoves. While thus occupied, a gentleman, one of the principal exhibitors of gas and other forms of stove, and of systems of ventilation, came up to me, and courteously began to point out the various objects of interest in that department. He especially drew my attention to certain forms of gas-burner, and of gas-stove, which he said gave off no smell and no smoke, and which he said were perfectly healthy. Among other things he pointed out was the perfect facility with which, by simple adjustment, the gas could be made to burn with a perfectly blue flame, and without any trace of white flame. He further volunteered, in explanation of the same, the statement that these special burners "burnt the air" and "burnt the gas," and that when more gas was burnt than air the flame always had a little whiteness about it. But, he said, "when these burners burnt exactly equal quantities of gas and of air—that is, when exactly 'half of each' was burnt—the whole was entirely consumed, and nothing was left, and that, therefore, the air that remained in the room was perfectly pure." More absolute ignor-

ance, or greater absurdity, than was here uttered on the subject it would be impossible to conceive. Yet this was the expressed wisdom of an authority—a great *maker* and *seller* of gas-stoves. If it remained with me I would punish severely, by heavy fine or imprisonment, every man who sold such a stove with such a recommendation of combined ignorance and falsehood.

Allow me in illustration of the science of these *pseudo* heat-reflecting gas-stoves to draw your attention to two simple experiments, which you may readily make for yourselves, the only apparatus required being one of your own fingers and a gas or a candle flame. Hold one of your fingers one-quarter of an inch from the *side* of a candle or gas flame—the heat is by no means unpleasant. Remove your finger to the distance of an inch from the flame, the heat will be 16 times less. Remove it to three inches from the flame—the heat reaching the finger by *radiation* from the flame will now be 144 times less than that which first reached it when nearest the flame. At six inches from the flame, the air being still, probably the warmth of the candle will not be perceptible to the finger. Thus it will be clear that a reflector placed six or seven inches from the flame will receive but a small or practically imperceptible quantity of heat. The quantity of heat reflected back from the bright copper surface, being necessarily less than that falling on it by radiation from the flame, will therefore be still less, and practically none.

As the bright copper surface is thus so inefficient and practically valueless as a heat reflector, whence the apparently great quantity of heat which *appears* to be reflected on to the hand when held opposite the front of the said gas-stove? Try another simple experiment. Hold your finger not one-quarter of an inch, but say two inches above the *top* of the flame—you will not hold it even at that distance from the flame many seconds: the heat even there is absolutely *intolerable*. What is the explanation of this? It is the following: The oxygen of the air, combining with the carbon and the hydrogen of the candle or coal gas, produces carbonic acid gas (carbon dioxide) and aqueous vapour, at the same time liberating their potential energy chiefly in the form of heat, by which the molecules of carbonic acid and of water are raised to a white heat. These intensely heated gases rise because of their comparative lightness, taking away their heat with them by what in technical language is termed "convection of heat." The hot particles of noxious or poisonous carbonic acid, which any proper system of ventilation would never permit to enter the room,

unable to escape from the top of the stove, come rolling, or rather flowing, out, a perfect cascade of hot poison from the opening in front, and impressing the ignorant and superficial observer with the false idea of the reflecting power of the stove. Such gas-stoves practically warm the air in the exact ratio in which they pollute it, and as I have said before, death but too frequently lurks in their use. They are, in fact, the very models of what stoves ought not to be, and they do exactly that which they ought not to do.

The limited time at my disposal in a single lecture necessarily prevents my entering more fully into the important question of *gas-stoves*. Doubtless there are gas-stoves to which the objections I have raised do not apply, but they are, as compared with coal or coke stoves, comparatively both more expensive and less efficient. There is, however, one form of gas-stove to which I should like to refer before I leave this subject, and that is the bright open red hot glowing gas fire, set up in the ordinary grate to simulate the common coal fire. The fire of this form of gas-stove is bright, glowing, and cheerful nearly as that of a common coal fire, but the warmth radiated into the room is probably not one-fourth of that of a coal fire of the same size. It is, moreover, expensive to fit up, and expensive in use. It is, however, very cleanly, and may be lit or extinguished at a moment's notice, without any of the dirt or trouble and loss of time required by the common coal fire. In this stove a row of Bunsen's, or smokeless, gas-burners is placed immediately below a common open fire-grate. Over these burners are placed a number of masses of pumice, asbestos, or other similar substance, about the size of an ordinary potato. On lighting the gas—which, when properly adjusted, burns with a blue, almost non-luminous, and smokeless flame—the solid masses of asbestos or other material very shortly become heated to incandescence, glowing with a bright red, or even white, light, closely counterfeiting that of a coal fire. There is one point of caution, however, to be observed here. Since the amount of heat directly radiated into the room by one of these gas fires is so much less than that of the common coal fire, the designer, seller, or fitter-up of the stove is tempted, unless carefully watched, to build up and contract the opening of the chimney until it becomes too small to carry off the poisonous products of combustion with sufficient rapidity. These heated gaseous products, therefore, in such cases, in part enter the room, greatly damaging, especially in bedrooms, the purity of the atmosphere, but apparently adding to the heating efficiency of the stove.

**Be sure you open your street door and the upper parts of all your bedroom windows, if for one or two minutes only, before retiring to rest.**

Every observant householder must have been struck, at one time or another, by observing, after cold frosty nights, the large quantity of water that is to be seen running down in streams on the inside of the bedroom windows, the upper bedrooms especially. Most of the water thus presenting itself has been formed at the expense of the oxygen of the air, and is evidence, though imperfect evidence only, of the *extent* of vitiation of the atmosphere in which we have slept. This accumulation of water—product of combustion and breathing—and this vitiation of the atmosphere during the night may be prevented to an enormous extent by the observance of this important rule.

The warmth of a room depends, not (excepting in a very slight degree) on the temperature of the air it contains, but on the temperature of its walls, and of the furniture it contains. If, therefore, the doors and windows of your house, or even the windows alone, be opened for a minute or two only, you entirely change the air of your rooms without practically lessening the heat-radiating power of the walls and the furniture.

**Do not wear tight clothing of any kind.**

Tight clothing of any kind, especially with feeble action of the heart, or with insufficient bodily exercise, lessens the circulation, lessens respiration, lessens the generation of animal heat, and therefore tends to starve and chill the body and thus to make it over-sensitive to cold and to even reasonable and unpreventable draught; and in too many cases leads to the habit of dram-drinking—for though alcohol *will not raise the temperature* of the body, it will render it *less sensible to the cold.*

A singular and interesting case of death caused by "tight clothing" was recorded in the London newspapers of last week. A lady fell down in the streets, was carried into a house, and shortly afterwards died. Medical examination showed she had killed herself by wearing too many, and too tight clothes. She was a woman with an abnormally weak heart, and consequently a very feeble circulation, and therefore felt most acutely the chill of the recent cold weather. She consequently took to wearing two pairs of stockings, two sets of everything, at the same time. Her circulation could not stand it, and she died as I have described.

**Be sure that when you sit in a small room, warmed by an open fire, that your feet are raised six to eight inches from the floor.**

A current of fresh cold air usually rushes through the opening under the door, spreading out as it flows towards the fire place. Avoid this chilling influence on your feet, and you will probably not feel obliged to rush and stop up the window chinks and other crevices, though nature otherwise insists on your receiving at least a portion of the fresh air required to supply that which necessarily escapes up the chimney, and without which the room would be filled with smoke.

**Do not put too many clothes upon the bed, and be sure the bed clothing is not too heavy.**

Bed clothing does not supply heat to the body, it simply assists in preventing its escape from the body. When the bed clothing is too heavy it chills by impeding the circulation, and thus frightens the occupant of the chamber into insufficient ventilation.

A very warm but inexpensive and comparatively durable form of blanket, well suited to the necessities of the poorer classes during these cold winter months, consists of two layers of perforated brown paper, sewn together, with a thin intermediate layer of cotton-wool. These blankets, now sold under the name of "Chartaline Blankets," are said to have the *warmth* of a thick flannel double blanket, while their *weight* is less than that of a single ordinary blanket.

**Be sure you do not sleep in a draught.**

During sleep all the active energies of the body are lowered. Cold, therefore, by the *nervous shock* it may produce, chiefly through the vasa-motor nerves, frequently gives rise to serious and even fatal disease. It is in this way that cold feet, or a draught of cold air on the head, in the case of persons of feeble circulation, even during waking hours, often produces inflammation of the lungs or the bowels.

**Do not sleep with your head under the bedclothes.**

To those who practice this habit I would say recollect our lighted-candle and gas-chimney experiment. You are here performing our gas-chimney-without-ventilation experiment over again—simply substituting for the lighted candle your own precious bodies, and sacrificing your own invaluable health. You are not only breathing air with less than its normal amount of

xygen gas, but you are breathing your own polluted breath. You re, as it were, also bottling-up and breathing the impure exhala- ons of your own skins. No wonder, then, that scrofula and ther forms of constitutional disease and debility are to be found n schools, and elsewhere, where such a habit prevails. To my oung friends especially I would say, beware! Beware of this abit if you would grow up men and women lithe and graceful, uoyant and healthy in mind and in body. And you parents, and choolmasters, and schoolmistresses, see you that the young eople entrusted to your care are not left uninstructed on this oint.

**Be sure that the walls of your rooms are not papered with arsenical wall-papers.**

The attention of the Sanitary Association having been drawn to he serious evil to health, which so frequently resulted from the ighly-injurious practice of using **arsenical colours** in the manu- acture of **wall-papers,** I have been requested to offer one or two emarks on this subject. I will give you, very briefly, two cases f poisoning caused by occupying rooms covered with arsenical all-papers, as described in the *Lancet* some five years ago :—

"A remarkably fine boy, aged ten weeks, at the breast (mother healthy nd strong), after being about ten days in a large airy room, the walls of which were papered with a new green unglazed paper, began to sicken as ollows: Cried frequently as if in pain, refused the breast, or, if he took it, was sick; looked pale and pinched; the whites of the eyes were pearly and glazed; the surface of the body was chilly, with clammy moisture; the bowel was irritable. and the motions were green and scanty mucoid." The cause becoming suspected, the child was removed into another room before he injury had gone too far, and gradually recovered.

The other case was that of a young married lady whose sitting-room was covered with arsenical wall-paper. "She had great nervous prostration, with excessive excitement and various forms of hysteria; there was broken sleep at night, watering and weakness of the eyes; a bitter metallic taste on he lips; loss of natural appetite, and often great thirst. She could not walk far without being quite worn out, and then suffered from palpitation f the heart. Worst of all, however, was the excessive vomiting, not only fter meals, but during the night. All forms of treatment failed to cure or relieve this patient, until at last her medical man ordered, by way of experi- ment, the walls of her room to be stripped of their paper, and re-papered with a different sort, after which, under treatment, she gradually recovered her health, and suffered, though living in the same room, no subsequent relapse."

Bright green flock wall-papers are the most dangerous, because f the facility with which the green-coloured arsenical dust is

rubbed, shaken, or even dried off the walls and made to commingle with the general atmosphere of the room. But other wall-papers—grey, and pearly, and in no wise green—also contain large quantities of arsenic. Mr. J. C. Wigner, F.C.S., reported in the *Lancet*, about a year since, that he had recently examined the wall-papers of a ten-roomed house in London, and that, though not one of these rooms was of a green colour, the wall-papers of five out of the ten rooms contained arsenic, some of them being very badly arsenical. There is no doubt, however, that any person letting a house or rooms whose wall-papers he warranted not to contain arsenic would be subject to penal consequences supposing any serious injury were to result from the presence of arsenic in such case.

No poison is perhaps more easily and certainly detected than arsenic. One of the best and most certain tests for *arsenic* is known as **Marsh's test.** I hold in my hand a "Marsh's apparatus." It consists simply of a glass tube or flask, with a well-fitting cork, through which a small tube-funnel passes to the bottom of the flask. From the upper part of the tube also proceeds a small glass tube or jet for the exit of gas. Into the larger tube or flask I place (1) a little *pure* zinc; (2) a mixture of pure hydrochloric acid and water, which I pour down the tube-funnel, and (3) a few small strips of the wall-paper I desire to test. *After* the gas, which now escapes in some quantity, has had time to expel all the air in the flask, I apply a light to it, and then hold a white plate in the middle of the flame. If the flame produces a *black* stain on the white plate you may be satisfied the wall-paper contains arsenic. Only one other substance—antimony—besides arsenic yields a similar black stain, and this is not generally used in the manufacture of wall-papers. Further, it may readily be distinguished from arsenic by any practical chemist.

This test, however, would not be quite safe in the hands of persons who have not had some little experience in practical chemistry, since, without due care, the whole is apt to "blow up," when the light is applied, thus endangering the eyes and faces of the operator and of those about him.

The test, however, which I am now about to introduce to your notice is a perfectly safe one, is very simple, and is one which may readily be applied by any builder, paperhanger, or person of ordinary intelligence. It was communicated to me by Mr. Payne (Mottershead & Co., chemists, St. Ann's Square), but was, I believe, first proposed by Professor Siebold.

Into this test-tube (about ¾in. diameter), I introduce to the depth of about of 1 or 1¼ inch, a mixture of equal parts of pure *hydrochloric acid* and water, and two or three small pieces of *pure zinc* (about the size of a pea), also a few small strips of the *wall-paper* to be tested. I now introduce, quickly, while the gas is escaping, a *loose* plug of *cotton-wool* (about ¾ of an inch in thickness), just dipped into a solution of *acetate of lead.* I lastly pour a few drops of a solution of *nitrate of silver* on to a piece of *white blotting-paper,* and *cover* the top of the test-tube closely with the *wetted* blotting-paper. If a round *dark* or *black* stain appears on the paper, corresponding with the mouth of the test-tube, the wall-paper contains arsenic. The experiment is made, if possible, more certain if you try *first* to get the black stain before introducing the wall-paper to be tested—that is, if you first make what the practical chemist terms "a blank experiment." Messrs. Mottershead & Co. tell me they can supply a small box fitted with all the necessary apparatus and materials for making these experiments at three shillings and sixpence per set. I am indebted to the kindness of Messrs. Heighway, of Deansgate, for the selection of arsenical and non-arsenical papers with which I have been enabled to illustrate this part of my lecture.

And now, in conclusion, regarding all crime, and nearly all human disease and physical suffering, as landmarks of ignorance, error, or misconduct, and therefore ultimately destined to disappear before an ever-advancing civilisation, may I express my hope that the hour and a half we have spent together this evening may in some slight degree, however small, tend to expedite this result?